विद्या सर्वार्थि साधिका

ANANDALAYA

PERIODIC TEST - 2

Class : XI

Subject: Physics (042) M.M : 70

Date : 03-10-2024 Time : 3 hours

General Instructions:

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. Section A contains sixteen questions, twelve MCQ and four Assertion- Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
5. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
6. Use of calculators is not allowed.

SECTION A

1. The dimensional formula of angular momentum is _____.
   (A) $[M^1L^1T^1]$ (B) $[M^1L^2T^{-1}]$ (C) $[M^1L^2T^1]$ (D) $[M^1L^1T^{-1}]$ (1)

2. In inelastic collision, _____ after the collision. (1)
   (A) kinetic energy increases (B) kinetic energy decreases
   (C) momentum increases (D) momentum decreases

3. The position of a particle is given by $\vec{r} = 3t\,\hat{\imath} - 2t^2\hat{\jmath} + 3\hat{k}$ where t is in seconds and the coefficients have the proper units for r to be in metres. The magnitude of velocity of the particle at t = 1s is _____. (1)
   (A) 4 m/s (B) 5 m/s (C) 8 m/s (D) 16 m/s

4. Identify the incorrect statement from the statements given below. (1)
   A particle in one-dimensional motion ____.
   (A) with zero speed at an instant may have non-zero acceleration at that instant.
   (B) with zero speed may have non-zero velocity.
   (C) with constant speed must have zero acceleration.
   (D) may have angle 0^0 or 180^0 between acceleration and velocity.

5. Rotational analogue of mass in linear motion is _____. (1)
   (A) Angular momentum (B) Torque (C) moment of inertia (D) centre of mass

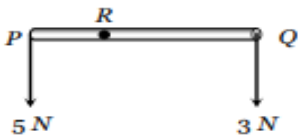
6. A ball of mass m moving with velocity v, makes a head on elastic collision with a ball of the same mass moving with velocity 2v towards it. Taking direction of v as positive, velocities of the two balls after collision are _____. (1)
   (A) -v and 2v (B) 2v and –v (C) v and -2v (D) -2v and v

7. 7.893 gram of a substance occupies a volume of 1.1 cm^3. The density of substance with appropriate significant figures is _____ g/cm^3. (1)
   (A) 7.1754 (B) 7.175 (C) 7.18 (D) 7.2

8. When two particles of same mass 'm' are dropped from a height 'h' and '2h' respectively, then the ratio of their times (t_1/t_2) to reach the ground is _____. (1)

(A) 1:2 (B) 2:1 (C) 1:$\sqrt{2}$ (D) $\sqrt{2}$:1

9. The resultant of the two parallel forces 5N and 3N acting at the ends of a rod PQ passes through R. If the system is in rotational equilibrium, the value of PR is _____. (1)

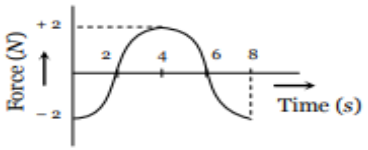


(A) $\frac{1}{4}RQ$ (B) $\frac{3}{8}RQ$ (C) $\frac{3}{4}RQ$ (D) $\frac{3}{5}RQ$

10. The direction of angular velocity vector is along the ___. (1)

(A) tangent to the circular path (B) inward radius (C) outward radius (D) axis of rotation

11. The force-time (F – t) curve of a particle executing linear motion is as shown in the figure. The momentum acquired by the particle in time interval from zero to 8 second will be ____. (1)



(A) $-2\ Ns$ (B) $2\ Ns$ (C) $-4\ Ns$ (D) zero

12. Find the torque due to a force $(\hat{\imath} - 3\hat{\jmath})N$ about the origin which acts on a particle whose position vector is $(\hat{\imath} + \hat{\jmath})\ m$. (1)

(A) $4\hat{k}$ Nm (B) $-4\hat{k}$ Nm (C) $(1 - 4\hat{k})$ Nm (D) $(1 + 4\hat{k})$ Nm

In the following questions (Q.No. 13 to 16), a statement of assertion (A) followed by a statement of reason (R) is given. Choose the correct answer out of the following choices.
(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is not the correct explanation of A.
(C) A is true, but R is false.
(D) A is false, but R is true.

13. (A): Distance travelled in n second has the dimension of displacement. (1)
(R): Distance travelled in n^{th} second is the distance travelled in particular second.

14. (A): Velocity versus time graph for a ball projected vertically upwards is a straight line. (1)
(R): The velocity of the ball is independent of acceleration at the maximum height when it is projected vertically upwards.

15. (A): Same force applied for the same time causes the same change in momentum for different bodies. (1)
(R): Impulsive force produces finite change in momentum in a body.

16. (A): Force of friction is a non conservative force. (1)
(R): Work done by non conservative force is path dependent.

SECTION B

17. The velocity of a particle depends upon time t, according to the equation $v = a + bt + \frac{c}{d+t}$. (2)
Write the dimensions of a, b, c and d.

18. Expalin why: (a) An athlete always runs some distance before taking a jump. (b) Cyclist leans inwards while negotiating a curve. (2)

19. Write any three points of differences between distance and displacement. What is the numerical ratio of displacement to distance? (2)

20. The displacement (in metre) of a particle moving along x-axis is $x = 5t^2 + 2$. (2)
Find instantaneous velocity and instantaneous acceleration at time t = 2 s.

OR

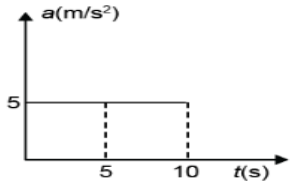
A car moving along a straight highway with a speed of 72 km/h is brought to a stop within a distance of 100 m. What is the retardation of the car and how long does it take for the car to stop?

21. A force $\vec{F} = 3\hat{\imath} - 3\hat{\jmath} + 3\,\hat{k}$ newton acts on an object and displaces it for $\vec{x} = 2\hat{\imath} - \hat{\jmath} + 3\,\hat{k}$ meters. What is the work done by the force? (2)

SECTION C

22. State and prove Work- Energy theorem for a constant as well as a variable forces. (3)

23. Acceleration – Time graph of a moving body starting from rest is shown in the figure. (3)



(a) Draw position–time graph and velocity-time graph for the motion of the body.
(b) Find the speed of the moving body.

24. Using uniformly accelerated motion graph, derive any two equations of motion. (3)

25. The velocity ($\boldsymbol{v}$) of a transverse waves on a string may depend upon length ($\boldsymbol{l}$) of string, tension ($\boldsymbol{T}$) in the string and mass per unit length ($\boldsymbol{\mu}$) of the string. Derive the formula for the velocity dimensionally. (3)

26. Read each statement below carefully and state with reasons, if it is true or false : (3)
(a) The magnitude of the dot product of two vectors is equal to area of parallelogram.
(b) Two vectors, $\vec{A} = 2\hat{\imath} + 3\hat{\jmath}$ and $\vec{B} = 8\hat{\imath} + 12\hat{\jmath}$ are in same palne and have same direction.
(c) Scalar quantity has same value for observers with different orientations of axes.

27. Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at angle θ. The coefficient of friction between road and wheels is μ. (3)

28. (a) State the law of conservation of angular momentum. (3)
(b) An ice skater is preparaing for a jump with turns and has his arms extended. His moment of inertia is 1.8 kg m^2 while his arms are extended and his spinning rate is 0.5 rev/s. In order to launch himself into the air with respect to ice, he increases his spinning rate by bringing his arms closer and as result of it, his moment of inertia reduces to 0.5 kg m^2. What will be his rate of spinning in air?.

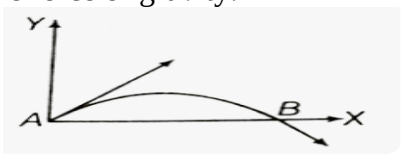
OR

A particle is constrained to move at a fixed distance r from the origin. A force F is acting on the object in a direction θ degrees from the position vector at an instant of time. If the force rotates the particle through an angle $d\theta$, show that the work done by a torque is $\tau\, d\theta$.

SECTION D

29. Projectile motion is the motion of an object thrown (projected) into the air, after the initial force that launches the object, air resistance is negligible and the only other force that object experiences is the force of gravity. The object is called a projectile, and its path is called its trajectory. The motion of a projectile is the result of two separate, simultaneously occurring components of motions. One component is along a horizontal direction without any acceleration and the other along the vertical direction with constant acceleration due to the force of gravity.

(i) The velocity of a projectile at the initial point A is $(2i + 3j)$ m/s. Its velocity (in m/s) at point B is _____. (1)



(A) $-2i - 3j$ (B) $-2i + 3j$
(C) $2i - 3j$ (D) $2i + 3j$

(ii) The horizontal and vertical displacements x and y of a projectile at a given time t are given by $x = 6t$ metres and $y = 8t - 5t^2$ metres. The range of the projectile in metres is _____. (Take g = 10 m/s^2) (1)

(A) 9.6 (B) 10.6 (C) 19.2 (D) 38.4

(iii) Prove that the maximum horizontal range of projectile is equal to four times the vertical height of it. (2)

OR

(iii) Show that for two complementary angles of projection of a projectile with the same velocity, the horizontal ranges are equal.

30. The centre of mass of a body is a point at which the entire mass of the body is supposed to be concentrated. The position vector $\vec{R}$ of C.O.M. of the system of two particles of masses m_1 and m_2 with position vectors $\vec{r_1}$ and $\vec{r_2}$ is given by $R_{CM} = (m_1 r_1 + m_2 r_2)/(m_1 + m_2)$. For an isolated system, where no external force is acting, V_{CM} is constant. Under no circumstances, the velocity of the C.O.M. of an isolated system can undergo a change. With the help of above comprehension, answer the following questions:

(i) Two identical masses move towards each other with velocities v and 2v respectively. The velocity of their centre of mass is _____. (1)

(A) v (B) 2v (C) v/2 (D) zero

(ii) Two bodies of masses 1kg and 2kg are located at (-1,2) and (2,-1) respectively. The co-coordinates of centre of mass are _____. (1)

(A) (1,1) (B) (1,0) (C) (0,1) (D) (-1,-1)

(iii) Give the location of the centre of mass of a sphere and a ring, each has uniform mass density. Does the centre of mass of a body necessarily lie inside the body? (2)

OR

(iii) Distinguish between centre of mass and centre of gravity.

SECTION E

31. (a) Derive an expression for the centripetal acceleration of a body moving with uniform speed 'v' along a circular path of radius 'r'. Draw relevant vector diagram. (5)

(b) A stone of mass 1 kg, tied to the end of a string of length 1 m, is whirled in a horizontal circle with a uniform angular velocity of 2 rad/s. What is the tension in the string?

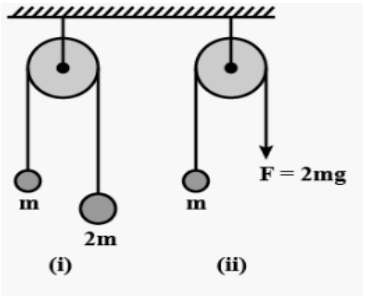
(OR)

(a) Analytically, find the resultant $\vec{R}$ of two vectors $\vec{A}$ and $\vec{B}$ inclined at an angle θ.

(b) At what angle should the two forces $2P$ and $\sqrt{2}\,P$ act so that the resultant force is $\sqrt{10}\,P$.

32. (a) What are concurrent forces? Obtain the condition for the equilibrium of three concurrent forces. (5)

(b) The two pulley arrangements shown in the figure are identical. The mass of the rope is negligible. In fig.(i) the mass m is lifted up by attaching a mass 2m to the other end of the rope. In fig. (ii) m is lifted up by pulling the other end of the rope with a constant downward force of 2mg. Calculate the ratio of accelerations in two cases.



OR

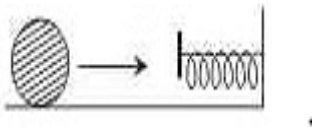
(a) A man of mass 'm' kg stands on a weighing scale in a lift which is moving downwards with a uniform velocity 2 m/s. What would be the reading on the scale ?

(b) The ratio of the weight of a man in a stationary lift and when it is moving downward with uniform acceleration 'a' is 3 : 2. What is the value of acceleration 'a'? (Take g = 10 m/s^2).

(c) What would be the reading, if the lift mechanism failed and it came down freely under gravity?

33. (a) Derive an expression for the elastic potential energy stored in a stretched spring. Show this energy graphically. (5)

(b) A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface collides with a nearly weightless spring of force constant k = 50 N/m. Find the maximum compression of a spring.



OR

Discuss the motion of an object in a vertical circle. Derive the expression for the velocity of the body and tension of the string at the lowest and highest points of the vertical circle.